

Mineral Composition of Kentucky Bluegrass Under Effluent Water Irrigation on Golf Courses



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Abstract

Golf courses in the western United States are increasingly being irrigated with effluent water. Kentucky bluegrass (*Poa pratensis* L.) (KBG) is the most widely used turfgrass species in Colorado. Research was conducted on eight golf courses, including three courses in Denver after 10 years of effluent water irrigation, three courses in the nearby cities receiving effluent water for more than 10 years, and two courses receiving surface water for irrigation. Soil pH, electrical conductivity (EC), organic matter, Ca, Mg, K, Na, B, and sodium adsorption ratio (SAR) of soil saturated paste were determined. Kentucky bluegrass shoots were sampled from 25 roughs and analyzed for mineral concentration including Na, Ca, Mg, K, Cl, B, S, P, Mn, Fe, Zn, Cu and Mo. Effluent water irrigation increased clipping Na concentration by 4.3-9.9 times, Cl by 1.5 - 1.3 times, B by 1.3 - 3.5 times, whereas tissue K/Na ratio was reduced by 74- 90%. Multiple regression analysis was conducted to identify the relationships between mineral concentration in clippings and turf quality. There was a negative linear relationship between turf quality and sodium content in the clippings ($R^2=0.65$). Soil SAR in 0-20 cm depth was highly associated with KBG shoot Na as documented by a logarithmic regression of $R^2=0.70$.

Introduction

- ✓ Water deficiency is well known in western states including California, Nevada, Arizona, Utah, Colorado and New Mexico (National Drought Mitigation Center, 2016).
- ✓ Denver, as it is situated in the semi-arid geographic location often has to deal with drought in the summer seasons. From April through October, more than 50% of the city's potable water is used for outdoor landscape irrigation purposes.
- ✓ Qian et. al. (2001) tested KBG leaf water potential, osmotic potential, and shoot mineral content under saline treatments ranging from 2.2 to 14.2 dSm⁻¹. Cultivar 'Limousine' had less shoot Na⁺ and Cl⁻ accumulation and a higher shoot K⁺/ Na⁺ ratio. Shoot growth reduction of 25% for 'Limousine' was observed at EC 4.7 dSm⁻¹.

Objectives

- 1) To evaluate KBG turf quality grown on golf courses irrigated with effluent water from different water treatment authorities for different years.
- 2) To determine the relationship between KBG turf quality and shoot mineral concentrations and soil chemical properties.

Materials and Methods

- ✓ Soil and turf clipping samples were collected from three courses in Denver that switched to effluent water irrigation from Denver Water in 2004; three golf courses from Thornton, Broomfield, and Aurora that observed turfgrass decline after effluent water irrigation for more than 10 years; and two courses irrigated with surface water in the region as control.
- ✓ Soil pH, EC, Ca, Mg, K, Na, B, Cl, P, organic matter, and SAR were analyzed.
- ✓ Kentucky bluegrass shoot minerals including Na, Ca, Mg, K, B, S, P, Mn, Fe, Zn, Cu and Mo were tested using ICP-AES method; Cl concentration was analyzed by the Cl⁻ selective electrode.
- ✓ Correlation test was performed by Proc CORR. Stepwise regression was conducted to determine if minerals accumulated in shoot tissues were related to the decline of turf quality. Significance was chosen at the probability level of 0.05 (SAS 9.3, 2011).

Results

Table. Mean separation of turf quality and clipping mineral concentration of Kentucky bluegrass grown on golf courses under different years of effluent water irrigation.

	Surface Water (0 Year)	Denver Effluent Water (10 years)	Thornton, Westminster and Aurora (10-21 years)
Turf quality	8.2a	7.8a	7.1b
Na	329c	1427b	3256a
Ca	3856b	3426b	5159a
Mg	1874b	2725a	1780b
K	20637ab	22642a	17372b
Cl	5027b	7545a	6734a
B	5.9b	7.7b	20.8a
K/Na	64.3a	16.6b	6.3c

Means within a row followed by the same letter are not significantly different based on LSD (0.05). Units are mg kg⁻¹ except for turf quality and K/Na ratio.

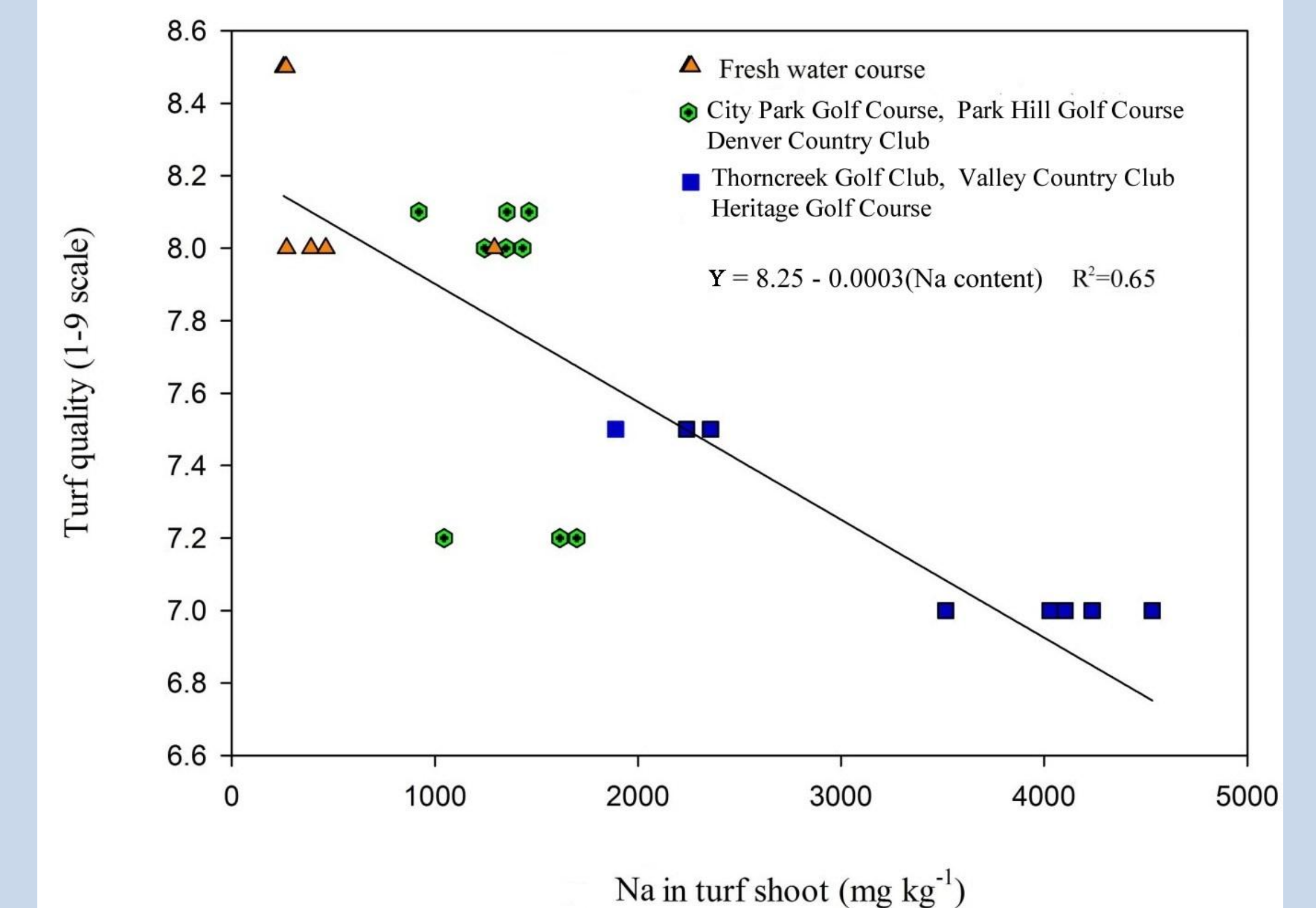


Figure 1. Regression analysis of shoot Na concentration to turf quality under three irrigation schemes.

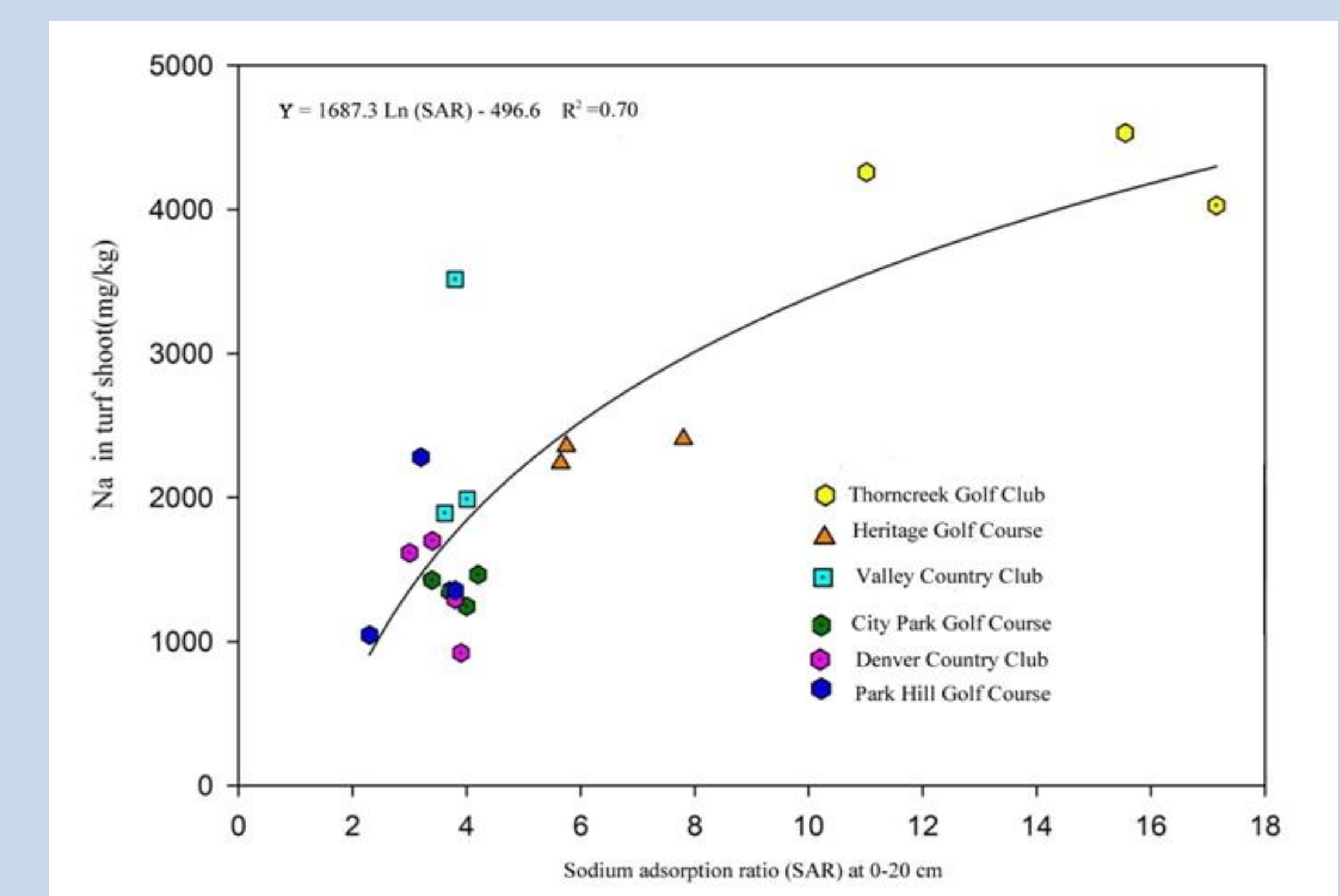


Figure 2. Logarithmic regression analysis of soil SAR (0-20cm) to corresponding turf shoot Na concentration under different effluent water irrigation schemes.

Conclusions

- Turf quality decreased after more than 10 years of irrigation with effluent water (from 8.2 to 7.1).
- K/ Na ratio was significantly different with 3 treatment groups.
- Stepwise regression of turf quality vs. 13 minerals and K/Na ratio indicated that sodium was the only element that strongly and negatively influenced turf quality ($R^2=0.65$).
- Soil SAR in 0-20 cm depth was highly associated with KBG shoot Na content.

Acknowledgement

